



# DESIGN AND DEVELOPMENT OF WHEELCHAIR CUM BED

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## ABSTRACT

The common Handicap wheel chair type mostly used in hospital is the Standard Wheelchair. People with considerable upper body strength like arms, shoulders, back and trunk are prefer to use a light weight wheel chair to move forward with force by arm strength. Manual wheel chairs are distinguished by the two small caster wheels in front and two large wheels in back, hand rims attached to the two larger rear wheels which manually propelled by the user himself. These are the objectives of wheel chair

- To design and fabricate the frame of the chair cum bed which is foldable having pivoting at two points within the length.
- To design and make the axle holding the wheels which can be propelled by the hand or assistance.
- To design and fabricate the hydraulic pump with tank and handle lever to operate by the patient or the attendant.
- To design and fabricate the hydraulic pump which can actuate affecting the link mechanism to operate to chair to convert into bed and release when not required.
- To design and fabricate the link mechanism to be operated by the actuation of the cylinder ram, to lift the leg support up to make a part of the bed and to lower the back rest to make the other part of the bed.
- To design and fabricate the lever propulsion system of wheelchair which is to be propelled by the patient.

## NEEDS

- Patient wants to be independent.
- Patient transfer is something that taken very serious problem in hospitals.
- Patient to be capable of any movements.
- Easy handling and economical.

## I. INTRODUCTION

A **wheelchair** is a chair with wheels, designed to be a replacement for walking. The device comes in variations where it is propelled by motors or by the seated occupant turning the rear wheels by hand. Often there are handles behind the seat for someone else to do the pushing. Wheelchairs are used by people for whom walking is difficult or impossible due to illness (physiological or physical), injury, or disability. People with both sitting and walking disability often need to use a wheel bench.

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chair to move forward with force by arm strength. Manual wheel chairs are distinguished by the two small caster wheels in front and two large wheels in back, hand rims attached to the two larger rear wheels which manually propelled by the user himself.

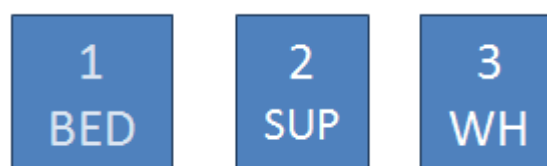
A basic manual wheelchair incorporates a seat, foot rests and four wheels: two, caster wheels at the front and two large wheels at the back. The two larger wheels in the back usually have hand rims; two metal or plastic circles approximately 3/4" thick. The hand rims have a diameter normally only slightly smaller than the wheels they are attached to. Most wheelchairs have two push handles at the top of the back to allow for manual propulsion by a second person.

Other varieties of wheelchair are often variations on this basic design, but can be highly customized for the user's needs. Such customizations may encompass the seat dimensions, height, seat angle (also called seat dump or squeeze), footrests, leg rests, front caster outriggers, adjustable backrests and controls.

## II. OBJECTIVES

1. To design and fabricate the frame of the chair cum bed which is foldable having pivoting at two points within the length.
2. To design and make the axle holding the wheels which can be propelled by the hand or assistance.
3. To design and fabricate the hydraulic pump with tank and handle lever to operate by the patient or the attendant.
4. To design and fabricate the hydraulic pump which can actuate affecting the link mechanism to operate to chair to convert into bed and release when not required.
5. To design and fabricate the link mechanism to be operated by the actuation of the cylinder ram, to lift the leg support up to make a part of the bed and to lower the back rest to make the other part of the bed.
6. To design and fabricate the lever propulsion system of wheelchair which is to be propelled by the patient.

## III. WORKING CONCEPT



**Fig.1 Present concept**

According to present concept to transfer patient from wheelchair to bed in vice versa it requires assistance.

## IV. LEVER DRIVE TRAIN MECHANISMS

Achieves a multi speed, fixed ratio drive train with lever system shown in fig 2. Unlike most gear trains, which operated in varied states to obtain multiple ratios, the lever propulsion drive train exists in only one state; it is the user who changes his hand position to change the mechanical advantage of the device. If more torque at the wheel is needed to climb a hill, the user simply slides his hands up the levers and away from the pivots, as

shown in fig 2a. achieving a greater angular deflection with every push stroke. The relationship between chair speed and hand speed is represented by eqn 1.

**Equation 1**

$$V_{Chair} / V_{Hand} = D_{CR} R_W / D_{FW} L$$

where  $V_{Chair}$  is the chair velocity,  $V_{Hand}$  is the users hand velocity,  $D_{CR}$  is the chainring diameter,  $R_W$  is the wheel radius,  $D_{FW}$  is the freewheel diameter, and  $L$  is the lever length.

**Fig 2. LFC variable mechanical advantage drive train**



a. Low gear: moving hands high on the levers produces high torque



b. High gear: moving hands low on the levers high angular speed

- The design of the LFC gear train geometry was driven by human power and force capabilities. Available upper body pushing power for propulsion at maximum efficiency (30% increase in heart rate from resting) was determined by adapting results from Woude, and was calculated to be 19.6W with a pushing force of 58N and hand velocity of 0.38m/s. Maximum attainable pushing force was determined to be 365N from US military tests on aircraft control sticks (8) – an interface geometrically similar to the LFC levers. These data were combined with the anticipated terrain in developing countries to determine the required lever size depending on resistance forces caused by rolling friction, air friction, and gravity. Road surface properties used in our analysis varied from tarmac to gravel to mud to sand, corresponding to rolling friction coefficients ranging from 0.005 to 0.5 (9, 10), and slopes between 0° and 40°, just beyond the backwards tipping angle of the LFC.

- Through our analysis we found that levers that can be grasped between 22cm to 86cm from the pivot will enable the rider to operate at maximum efficiency on common terrains (coefficient of rolling friction from 0.005 to 0.1 and slopes up to 5°) and generate enough torque at peak force output to overcome extremely harsh terrains (coefficient of rolling friction up to 0.45 and slopes up to 30°).

## V. WORKING PRINCIPLE WITH CONSTRUCTION DETAILS



**Fig.3. Working**

- This is a wheelchair which uses the leveraged handle which will support the torque reduction in driving, which can be easily moved by the lever utilizing upper body power for propulsion through a lever drive which will propel a chain sprocket to finally drive the small driven sprocket of the wheel. Such both the levers are driving two wheels which will help in easy maneuverable.
- The lever which is long can be used to propel and it can be held at the place convenient according to the torque requirement, the place of holding can be at long distance to the drive gear for better torque.
- The drive gear used here for driving another driven spur gear which is mounted on the drive sprocket. This method is given to reverse the direction since we need the torque and rotation transfer by pulling the lever which rotates the drive gear is clockwise and the driven spur gear rotating in anti-clockwise direction and the drive sprocket with 48 number of teeth will drive the driven sprocket in anticlockwise direction to move ahead the wheels during the pulling of the lever which is in opposite direction of the drive.
- The lever is pulled for the smaller distance which makes the gear to rotate for maximum 90 degree. The drive gear of 57 number of teeth which drives the driven gear of 38 number of teeth, by which the ratio of this method is  $57/38 = 1.5$ ; next the drive sprocket is of 48 number of teeth and the driven sprocket is with 16 number of teeth, the ratio by this method becomes  $48/16 = 3$ ; So the final ratio by these two methods will be  $1.5 \times 3 = 4.5$ . so when we pull the lever once, the rotation at the wheel axle will be  $4.5/4 = 1.125$ .
- The wheel diameter is 700mm and the circumference of that becomes 2199mm and once the lever is pulled for 90 degree angle, it will propel the wheel to rotate and travel the distance of  $2199 \times 1.125 = 2473$ mm.

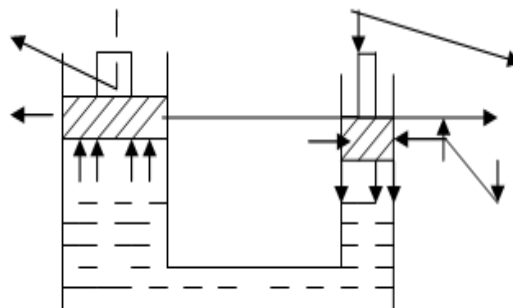
- So for one lever propulsion the wheel will cover a distance of 2.47meters distance and in normal wheel chair which is rim pushed, the propulsion is by hand pushing for entire circumference without any ratio and leverage.

## VI. HYDRAULIC RECIPROCATION

The second feature of this project is wheel chair cum bed which is effected by the links mechanism which converts the wheel chair into the bed. The actuation is by hydraulic force using the cylinder and the hand lever pump which is operated by the wheel chair user to covert the wheel chair into the bed.

Basically a hydraulic system consists of a pump and cylinder. One piston is small and on the other large effort is applied to the small piston pursuing it into the liquid and creating pressure throughout the liquid. The pressure then causes the larger piston to move, thus transmitting the effort. The force produced is equal to the liquid pressure multiplied by the area of the piston, so the large piston produces a greater force than that erected on the small piston depending upon the difference in their areas. It will also move a shorter distance than the smaller piston.

Force multiplication-----An interesting thing about hydraulic system is the ability to apply force multiplication. Imagine if cylinder 1 is 1inch in diameter, and cylinder 2 is 10 inch in diameter. If the force exerted on 1 is 10lbs,the force exerted on 2 is 1000lbs because 2 is hundred times larger in area ( $S=\pi \times \text{radius} \times \text{radius}$ ) as 1. The down side to this is that you have to move 1 a hundred inches to move 2 one inch.



### 6.1 Force Multiplication In Mechanical Systems

Let  $A$  = Area of the ram  
 $a$  = Area of the plunger  
 $P$  = Intensity of the pressure  
 $F$  = force applied on the plunger

$W$  = weight lifted by the ram

$N$  = efficiency

Since, the intensity of pressure in the chamber is same in all direction,

Therefore,

$$P = F/a \text{ ----- (1)}$$

$$F = P * a$$

$$W = P*A$$

$$P = W/A \text{ -----(2)}$$

Equating (1) and (2)

$$W = F*(A/a) \quad (\text{for } W)$$

$$F = W*(a/A) \quad (\text{for } F)$$

$$N = (W/F)*(a/A)$$

By applying the equation for work done, we can say work done by smaller piston = F\*S1 and work done by larger piston = W\*S2.

Where S1 and S2 are the distances moved by smaller and larger pistons respectively.

$$\text{Equating the two we can write} \quad F1*S1 = F2*S2$$

$$F2/F1 = S1/S2$$

Therefore energy input to the system is equals to the energy output from the system.

### 6.2 Design of Pump

The pressure put on the piston of the pump is to be calculated considering the pressure arm length, lever x the pressure applied on the hand lever, say approximately 5kg applied on the hand lever, considering the leverage the approximate force on the piston may be 40kg which is to be termed the pressure on piston, calculating the area of the piston of the pump with force, we will get the working pressure of the fluid which is to be used for the cylinder ram force resulted at the shaft , considering the diameter of the cylinder ram as 25mm.

Diameter of the pump piston=15mm=1.5cm.

$$\begin{aligned} \text{Area of pump cylinder} &= \frac{\pi D^2}{4} \\ &= \frac{3.143}{4*(1.5)*2} = 1.7671\text{cm}^2 \end{aligned}$$

Pressure lever length = 35cm.

Pressure arm pivoted at (force arm) = 4cm

Assuming pressure applied on hand lever = 5kg.

Pressure arm x pressure = force arm x force.

35 x 5 = 4 x force.

$$\text{Force} = \frac{(35*8)}{4} = 43.75\text{kg}.$$

Pressure in the pump

$$\text{Fluid pressure} = \text{force/area} = \frac{43.75}{1.7671} = 24.75 \text{ kg/cm}^2.$$

Pressure at the cylinder ram = pressure x area of cylinder ram.



### 6.3 Design of Gear

No of teeth's on driver gear: 57

No of teeth's on driven gear: 38

Diameter of driver gear: 116mm

Diameter of driven gear: 76mm

Pitch: 6mm

$$\text{Gear ratio} = \frac{\text{No of teeth's on driver gear}}{\text{No of teeth's on driven gear}} = \frac{57}{38} = 1.5$$

$$\text{Module} = \frac{\text{Dia. of driven gear}}{\text{No of teeth's on driven gear}} = \frac{76}{38} = 2$$

### 6.4 Design of Sprocket

No of teeth's on driver sprocket: 48

No of teeth's on driven sprocket: 16

Pitch: 12mm

$$\text{Gear ratio} : \frac{\text{No of teeth's on driver sprocket}}{\text{No of teeth's on driven sprocket}} = \frac{48}{16} = 3$$

Total gear ratio= (Gear ratio of gear) \* (Gear ratio of sprocket) = 1.5\*3 = 4.8

### 3.5 Design of Wheel/Tyre

Dia. Of wheel: 700mm

Circumference:  $2\pi r = 2 * \pi * 350 = 2199.11\text{mm}$

When we pull the lever by 30° (i.e. 180/30=6)

Distance travelled is

$$= 2199.11 * (4.5/6) = 1649.33\text{mm} = 1.65\text{m}$$

### 3.6 Design of Chain

Center distance (x) = 400mm

Pitch (p) = 12mm

No of teeth's on driver sprocket (z<sub>2</sub>): 48

No of teeth's on driven sprocket (z<sub>1</sub>): 16

Length of the chain = K\*p

$$K = \frac{z_1 + z_2}{2} + \frac{2x}{p} \left[ \left( \frac{z_2 - z_1}{2\pi} \right) \right]^2 (p/x)$$

$$K = \frac{16 + 48}{2} + \frac{2 * 400}{12} \left[ \left( \frac{48 - 16}{2\pi} \right) \right]^2 (12/400)$$

$$K = 83.87$$

Length of the chain = K\*p = 83.87\*12 = 1006.51mm



## VII. FABRICATION DETAILS & DESCRIPTION

- **Axle holding frame**-----this is made out of mild steel square tube being cut from the size of 20mm x 20mm for the length of 150mm-----4nos, 125mm-----2nos and 20mm x 40mm rectangular tube of length 480mm---1nos and then all are hammered at the end and ground to remove sharp corners at the end and then joined to make the frame as per the sketch to hold the axle with bearing housings being welded at the ends to hold the axle within.
- **Wheels with rim, tire, and tube**-----these are the standard bicycle rim with tire and tube being bought from the market with the sprocket holder hub being bought in assembled condition. The diameter of the wheel with tire is 700mm. such two number of wheels are used in this project.
- **15mm dia ball bearing housing**----mild steel----12nos.
- **15mm dia ball bearings**-----standard-----12nos.
- **Wheel axle**-----this is made out of C30 steel round bar being cut from the size of 20mm for the length of 250mm---2nos and then turned on lathe machine to make the diameter as
- **Driven sprocket**-----C30 steel-----2nos.
- **Drive sprocket**-----C30 steel-----1nos.
- **Bush for drive sprocket**-----this is made out of mild steel round bar cut from the diameter of 40mm for the length of 20mm and turned on lathe machine to make the diameter as 34mm and step turned for the diameter of 30mm to suit the drive sprocket inner diameter of 30mm for the length of 4mm. the other side of the diameter 34mm is faced to make 34mm diameter for the length of 10mm and maintaining the total length as 34mm. this bush is then welded to the drive sprocket.
- **Drive spur gear**-----this is a spur gear made out of C30 steel being used from the automobile gear box of outer diameter 116mm with 57 number of teethes and inner diameter is of 44mm for which a mild steel round bar is turned and bush is made to suit the inner diameter of length 12mm and then inner diameter of this bush is made as 15mm to suit the axle diameter of 15mm.
- **Driven spur gear**----- this is a spur gear made out of C30 steel being used from the automobile gear box of outer diameter 76mm with 38 number of teethes and inner diameter is of 44mm for which a mild steel round bar is turned and bush is made to suit the inner diameter of length 12mm and then inner diameter of this bush is made as 15mm to suit the axle diameter of 15mm.
- **Seat frame with footrest**----this is made out of mild steel square tube cut from the size of 20mm x 20mm of lengths 410mm---3nos, 510mm---2nos, 400mm---2nos, 240mm---2nos. all are made straight and then corner grinding is done to remove the sharp corners and cutting burr. This is made to rectangular frame of outer size 510mm x 410mm and vertical drops are welded of length 400mm at both the sides and then extension of 240mm for leg rest are welded to this frame. Then flats of size 20mm x 3mm thick cut for the lengths of 240mm---5nos, 410mm---1nos and then hammered for straightening and then joined to make the foot rest as per the sketch and then all are ground to remove the sharp corners.
- **Leg support**-----this is made out of mild steel square tube of size 20mm x 20mm cut for the lengths of 370mm---2nos, 710mm---2nos and then corner grinding is done to remove cutting burr and then joined to make the rectangular frame of outer size 710mm x 410mm. and grinding is done to remove the welding





burr and then this is welded with the hinges to the main frame and is hinged to the lifting link actuated by hydraulic.

- **Back rest**----- this is made out of mild steel square tube of size 20mm x 20mm cut for the lengths of 370mm---2nos, 355mm---2nos and then corner grinding is done to remove cutting burr and then joined to make the rectangular frame of outer size 355mm x 410mm. and grinding is done to remove the welding burr and then this is welded with the hinges to the main frame and is hinged to the lifting link actuated by hydraulic.
- **Back vertical**-----this is made out of mild steel tubes of size 40mm x 20mm cut for the length of 420mm---1nos, 425mm-----1nos and then grinding is done to remove the cutting burr and then joined at the center to make the vertical T type structure to support the back rest. This is welded to the main frame from the side supports. At the end at bottom, a flat of 80mm x 60mm x 3mm thick plate is welded to be able to weld the castor wheels on it.
- **Support for back vertical**----this is made out of mild steel tube of size 40mm x 20mm being cut for the lengths of 500mm and end taper cutting is done to suit the welding angle to support the back vertical from the side frame. Such two number are cut and joined by welding to the frame and back vertical to provide structural support.
- **Guide channel**-----this is made out of mild steel angle being cut from the size of 20mm x 20mm x cut for the lengths of 280mm-----4nos and then flattened by hammering and then two angles are joined to make the channel to make the inner size for bearing to slide of outer diameter 35mm within this channel. Accuracy is maintained to slide the bearing within this and welded and such two channels are made for this project and both are inner joined by the flats to have the guide channel as per the sketch.
- **Slide axle**-----this is made out of C30 steel round bar being cut from the size of 25mm cut for 125mm and then turned on lathe machine to make the diameter as 20mm for the entire length and step turned at both the ends to make the diameter of 15mm to suit the ball bearing inner diameter for the length of 10mm each side. Such two number of slide axle are made for this project.
- **Ball bearing for slide axle**----these are the standard ball bearings of inner diameter 15mm and outer diameter 35mm and thickness 10mm. such 2nos of ball bearings are used in this project.
- **Cylinder clamp**-----this is made out of mild steel flat of size 20mm x 3mm thick being cut and bent to make the shape to suit the cylinder outer diameter of 40mm and side bent to make the collar for drilling and facilitating the fastener fixing. Such four number of clamps are made and joined to each other to make the cylinder clamp made in two sets, one set being welded to the main frame and the other set being holding the cylinder with fastener to that clamp.
- **Support for cylinder holding**---this is made out of mild steel rectangular tube of 40mm x 20mm cut for the length of 300mm and is welded to the supports at the base of the wheel chair to be able to support the cylinder holding on it for sliding action actuation.
- **Vertical lift for slide**-----this is a mild steel flat being cut from the size of 25mm x 6mm for length of 40mm and flattened by hammering and then marked for the hole of 10mm at the distance of 30mm from one side.



- **Back rest lift flat**-----this is made out of mild steel flat being cut from the size of 25mm x 6mm for the length of 55mm and flattened by hammering and then marked for the hole of 10mm at the distance of 40mm from one side. This is then welded at the appropriate place.
- **Leg support lift flat**-----this is made out of mild steel flat being cut from the size of 25mm x 6mm thick being cut for the length of 80mm and then flattened by hammering and then marked for the hole of 10mm diameter at the distance of 40mm from one side and this is welded to the frame.
- **Back rest link**-----this is made out of mild steel flat being cut from the size of 25mm x 6mm thick being cut for the length of 240mm and flattened by hammering and then bent at one end to have the leg height of 40mm and then marked for the holes of 10mm at the center distance of 180mm from each other and drilled for the holes and then this is used as the link.
- **Leg rest link**-----this is made out of mild steel flat being cut from the size of 25mm x 6mm thick cut for the length of 490mm and then hammered for flattening and then marked for the holes at the center distance of 470mm and drilled for the holes of 10mm to be able to use as link.
- **Ram for hydraulic actuator**---It is made out of C30 steel, round bar of diameter 25mm being cut for the length of 150mm and turned on lathe machine to make the diameter 24mm collar for the length of 6mm, 16.3mm at one side for the step of 6mm, and 22.4mm diameter for the length of 135mm with the end chamfer for the length of 3mm. This turned ram is then loaded on cylindrical grinding machine to maintain the diameter as 16mm to suit the PU seal, 22mm diameter.
- **Housing for actuator**-----this is made out of C30 steel round bar of diameter 65mm being cut for the length of 35mm and then turned on lathe machine for the diameter of 64mm and then drilled, bored and then threaded for the size of M30mm, 2mm pitch to suit the cylinder threading, for the depth of 19mm. Cross drill is done from the circumference and tapped to suit the 1/8inch BSP threading and then taper drilling is done to match the center hole
- **Cylinder actuator**-----This is made out of C30 round bar of diameter 32mm cut for the length of 155mm and turned on lathe machine for the diameter of 30mm and drilled and bored for the internal diameter of 23.8mm. It is then threaded at both the ends for the size of M30x2mm pitch for the length of 25mm. It is then loaded on internal cylindrical grinding to grind the internal diameter for the size of 24mm to suit the sliding of the ram with PU seal.
- **Guide ram for hyd actuator**---C30 steel-----1nos. this is made out of C30 steel round bar of diameter 40mm cut for the length of 18mm and then turned on lathe machine for the diameter of 22mm and a groove of 25mm diameter for the width of 3mm. threading is done from the other side for the diameter of M30, 2mm pitch to suit the cylinder threading.
- **PU seal for actuator**--24 x 26 x 6mm standard--1set.
- **O ring for actuator**-----dia 28mm x 3mm-----2nos.
- **Hex connector**----1/4inch threading-----2nos.
- **Hose pipe with connectors**---standard-----1set



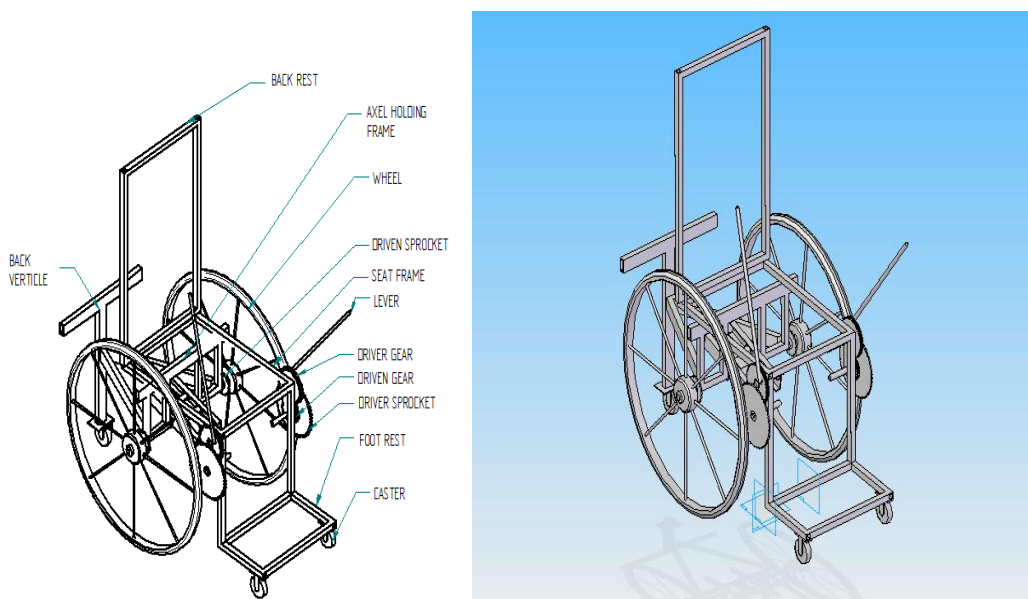
### 7.1 Hydraulic Reciprocating Hand Pump

- **Handle pipe**-----This is made out of standard extruded pipe of diameter 24mm for the length of 400mm being cut and step turning is done from outside to suit the bore of the yoke.
- **Handle grip**-----This is a standard item being bought from the market. This is made of poly vinyl chloride.
- **Handle yoke**-----This is a standard pipe of diameter of 25.4mm with internal bore of 21.6mm to suit the handle being turned, is being welded to the flat with a side hole of 6mm from two sides one at the edge and one at the side to facilitate the plunger holding.
- **Circlip**---6mm, C type Link-----This is a standard type being bought from the market.
- **PU seal**----12x8x7---It is a poly-urethane material seal being bought from the market.
- **Plunger housing**-----This is made out of casted steel being casted as per the mould being made. It is then machined for boring and drilling and tapping as per the requirement. The outsize maintained is 85mm x90mmx110mm. It is bored to suit the plunger diameter and counter bored to suit the ball and non return valve for springs and threading to suit the screw.
- **O ring**-----22x2csd It is a bought item being purchased from the market. This is Neoprene rubber.
- **Plunger**-----This is made out of C30 steel of diameter 20mm and step turned for the size of 15mm for the length of 158mm and total length of 180mm and flat milling is done at 15mm diameter side and cross drilling is done to hold it with the handle yoke.
- **Reservoir tube-or Pump housing**. -----This is a extruded tube of size 78mm outside diameter and 67mm inside diameter for the length of 110mm. It is being finished for the internal diameter of 68mm and counter bored for the step diameter of 70mm at end and tapered as per the drawing and counter faced and tapered at the other end for the depth of 5mm. This is to facilitate to fix it with top flange and bottom.
- **Suction valve housing**---This is made out of C30 steel of diameter 20mm turned and step turned for the size of 16mm and bored for the size of 10mm, 12mm making provision of seating the ball and the spring into it.
- **Connector or pump end flange**--- This is made out of mild steel of diameter 80mm being cut for the size of 55mm being turned on lathe machine to make the step diameters as 76mm for the length of 25mm and 70mm for the length of 13mm and 27mm for the length of 2mm and 22mm for the length of 14mm. the center is drilled at one end for the diameter of 8mm for the depth of 26mm and the counter drilled and bored for the diameter of 8.5 and M10 threading is done at one end and at the other side, drilled for the size of 4mm for the depth of 16mm and counter drilled and bored and threading is done M16 to suit the plunger housing end.
- **Spring**-----This is a standard item of size 13dia outside and wire diameter of 1mm for the length of 30mm being bought from the market.
- **Ball**-----It is a standard item being bought from the market.
- **O ring**----65x2.5csd---It is a bought item being purchased from the market. This is Neoprene rubber.
- **O ring**-----15x2csd--- It is a bought item being purchased from the market. This is Neoprene rubber.
- **Ball**---6diameter. This is standard item being bought from the market.

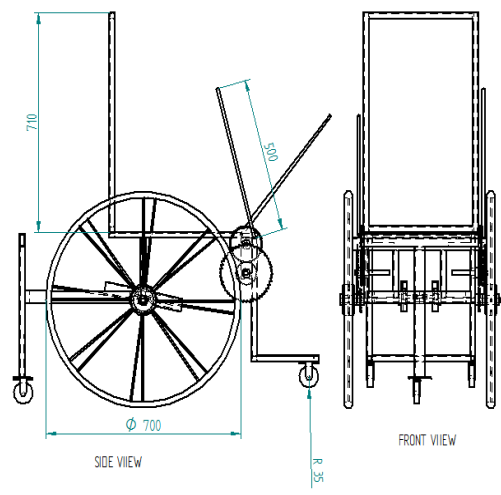


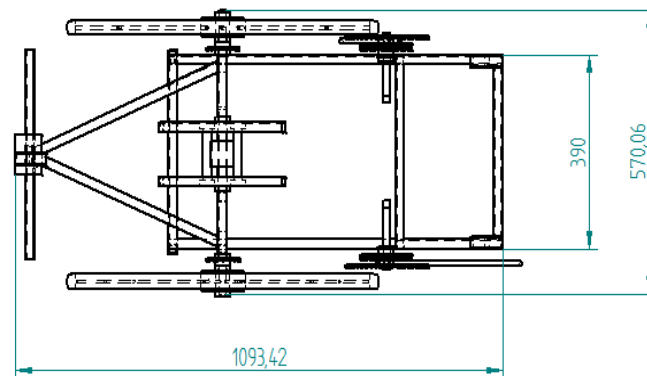
- **O ring**-----10x2csd It is a bought item being purchased from the market. This is Neoprene rubber.
- **Ball**-----4dia, It is a standard item being bought from the market.
- **Spring**-----relief spring---It is a standard item being bought from the market.
- **O ring**-----65x2.5csd It is a bought item being purchased from the market. This is Neoprene rubber.
- **Ball**-----5dia—It is a standard item being bought from the market.
- **O ring**-----10x1.8csd. It is a bought item being purchased from the market. This is Neoprene rubber.
- **O ring**-----6x1.5csd It is a bought item being purchased from the market. This is Neoprene rubber.

### VIII. ISOMETRIC MODEL OF WHEELCHAIR



#### 8.1 Different Views of The Chair





TOP VIEW

## 8.2 Live Image of Wheelchair



## IX. RESULT, DISCUSSION & SCOPE FOR WORK

- By experimenting it is found that , the person can operate himself or with less assistance
- Self confidence level is increased.
- While in transferring mode there is no injuries to the person.
- Cost is less compares other techniques.
- The TRIZ method adopted was found to be a handy to arrive the concept.
- The variable mechanical advantage attained from the lever drive enables the user to travel quickly and efficiently on smooth, flat roads.
- It can be made in any workshop without much skill and can be maintained easily and also serviced anywhere.
- It is efficient, compact and is operational flexible.
- It will fulfill the mobility needs of people with disabilities in developing countries.
- It is best suited to be used or maneuverable within home and hospital.

### **9.1 Scope for Future Work**

1. Evaluation of performance by the affected parties.
2. Redesign of wheelchair in the event of critical feedback.
3. Design for reverse mechanism through means of lever propulsion.

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